June, 1924 Extension Bulletin No. 122

Dry Rots of Corn and Their Control

IMPERIAL BUREAU OF MYCOLOGY
1 JUN. 1929

Two of these seed ears are diseased. One has Diplodia dry rot, another Basisporium dry rot, and the third is healthy.

EXTENSION SERVICE
AGRICULTURE AND HOME ECONOMICS
R. K. BLISS, Director
AMES, IOWA

Issued in furtherance of the Acts of Congress of May 8 and June 30, 1914.

DRY ROTS OF CORN AND THEIR CONTROL

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Poor seed corn results inevitably in a poor crop. Dead and weak seed is due either to early frost or to diseases caused by molds infecting the ears. Two of the most common and destructive diseases of corn in Iowa are Diplodia dry rot, caused by the mold known as *Diplodia zeae*, and Basisporium dry rot caused by another mold, *Basisporium gallarum*.

Fig. 1—Small black fruiting bodies near joint and on shank, which are full of the spores of the mold.

DIPLODIA DRY ROT

The first of these diseases, Diplodia dry rot, occurs on all parts of the plant, including ears, stalks, and roots. The mold reduces the stand by killing or weakening the seed corn, by dwarfing the plants and by molding the ears so that they are unfit for feed or seed.

In 1922 this disease caused a loss of 40,000,000 bushels of corn, and in 1923 65,000,000, and in addition reduced the vitality of the 1923 and 1924 seed corn 14 and 15 percent, respectively. The injury to seed was reflected in the stand and the yield.

SIGNS OF DIPLODIA DRY ROT

Diplodia dry rot occurs on all parts of the corn plant, but is most prevalent on the joints of the stalks and the butts of the ears.

On the stalks—The most common points of attack on the stalk are the lower joints where the base of the leaf blade forms a cavity in which pollen and moisture readily collect. Spores of the Diplodia mold lodge in this cavity and grow into the stalk, producing a water-soaked, discolored appearance on the green stalk extending above and below the joint. As the mold continues its growth the joints become weakened and often the stalk breaks at this point.

Diplodia dry rot is most marked and easily detected on the joints and ear shanks when the crop is mature. At this time the small black fruiting bodies of the Diplodia mold become very numerous and distinct as shown in fig. 1. In these bodies are produced thousands of very tiny spores, which are discharged the following year and may attack the new crop.

On the ear—If the shank becomes infected the ear may be either shrunken and shriveled or badly molded at the butt. This latter condition is usually the result of the entrance of the mold at the base of the ear. In other cases, the Diplodia mold may enter at the tip of the ear, producing a white, moldy appearance. In still other cases, many infected ears show no signs of the mold at all, although badly shrunken and discolored

kernel tips indicate its effect and presence. In such cases the mold can only be detected with certainty through germination tests. Such an ear is shown at the right on the cover page. On the germinator the presence of the Diplodia fungus is manifested as a cream colored, cottony mass, covering the kernels.

Little infection occurs on the roots and damage to the plant in that way is negligible. There are, however, many organisms in the soil which work on corn roots after such insects as corn root worms and wire worms and high winds have injured them. These organisms are secondary and cause but little damage. It is such conditions that constantly suggest the idea of "root rot," which should not be confused with dry rots under discussion.

EFFECT OF MOISTURE AND TEMPERATURE ON DIPLODIA DRY ROT

Diplodia dry rot infection is greatly influenced by the temperature and moisture. The mold grows most rapidly at about 86° F., altho it may grow at any temperature between 55° and 95° F. These temperature conditions prevail during the summer and early fall when corn is maturing.

Moisture is of greatest importance in the spread of the disease. It has been found that heavy rainfall when the corn is ripening is usually followed by a high percentage of dry rot. In many fields in Iowa the past fall, from 5 to 20 percent of the ears were either partially or wholly molded, making them unfit for seed or sale. The effect of the mold on the ears which are selected for seed is very pronounced if the cob is full of moisture. On many seed ears, a small amount of mold at the base of the ear, though invisible, may spread and seriously injure the seed. For this reason the ears should be dried as rapidly as possible and stored in a cool, dry place.

Weather conditions at corn planting time have considerable effect on the damage to the stand caused by the Diplodia mold. Only the healthy seed is able to produce a normal stand.

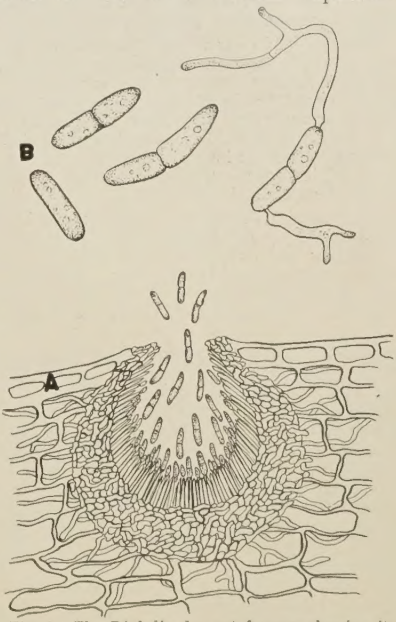

Fig. 2—The Diplodia dry rot fungus, showing its methods of spore production and their subsequent growth and development. The spores of this mold are borne in little black cases shown in Fig. 1. *A* shows the interior of these cases and *B* the spores before and after germination.

EFFECT OF DIPLODIA ON GERMINATION, STAND, AND YIELD

Because of the high percentage of moldy ears in the fall of 1921, it was thought advisable to make very careful tests of seed corn which had been selected for the following year. Accordingly, germination tests were conducted in the spring of 1922, in five counties.

Weak seed—In these five counties a number of farmers who were interested in the problem each furnished 100 ears of seed corn. A total of 5,000 ears were tested by the modified rag doll method. The results showed that 14.4 percent of these ears were unfit to plant because of the presence of dry rot. In 1923 a total of 5,550 ears of seed corn were tested by the same method as in 1922 and it was found that 14.6 percent was unfit to plant. Again in the spring of 1924, 7,500 ears have been tested in 16 counties, and results show that 18 percent of them are unfit to plant because of dry rot. Such conditions as described above are very striking in view of the fact that both 1921 and 1922 were very favorable for maturing corn, i. e., there were no early frosts. Diplodia dry rot injury must be watched and guarded against, as carefully as frost damage.

Poor stand—In connection with the germination tests described above, samples were selected for planting as follows:

From each 100 ear sample furnished by farmers, 10 healthy ears and 10 infected with Diplodia dry rot ears were selected on the basis of the germination reading. The healthy ears showed no signs of mold and every kernel tested produced good strong sprouts. The Diplodia dry rot infected ears selected were those which showed an average of one dead and two weak. It should be emphasized that the Diplodia dry rot infected ears to all outward appearances were good seed ears showing no visible signs of infection. The corn in this sample appeared as good, judging from all superficial characteristics, as the healthy sample.

The samples of healthy and dry rot infected corn were prepared for planting simply by shelling each 10 ear lot separately, which gave one lot of healthy and one of Diplodia dry rot infected corn from each 100 ear sample supplied by the farmers. In addition, each farmer furnished a pint of shelled seed corn which he had prepared for his own planting. This was designated as "farmers seed corn."

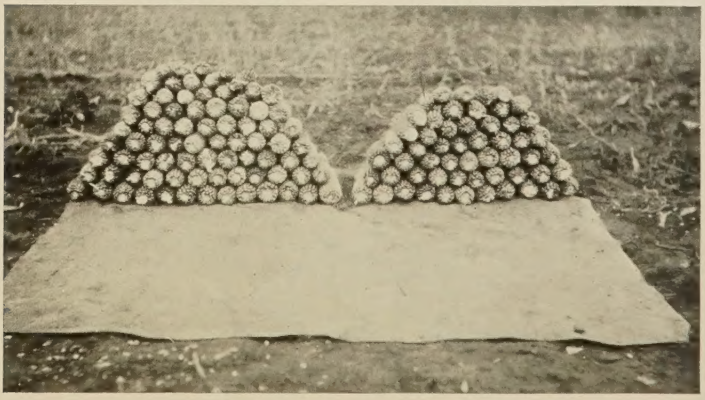

Fig. 3—Comparison of yield from rows planted with healthy and Diplodia dry rot infected seed. The former yielded 68 bushels and the latter 51 bushels per acre.

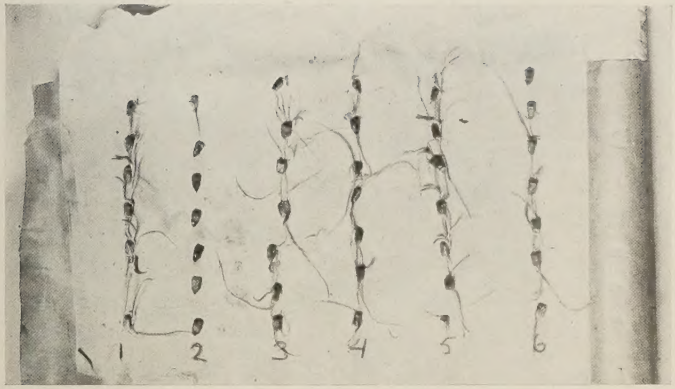

Fig. 4—Modified rag doll showing corn from healthy and Diplodia dry rot infected ears. Note the effect of mold on ear No. 2.

The above samples were planted by hand, three kernels placed in each hill, except in Sioux county where four kernels were used. Three replications were planted from each sample and the average of the three taken in computing the yield. Counts on stand were made when the corn was from 4 to 6 inches high. Table I gives a comparison of the stand in the rows planted with the three samples described.

It should be noted that even very slightly Diplodia dry rot infected seed corn gave an initial stand 8.6 percent in 1922 and 12.1 less in 1923 than the healthy seed.

In addition to the reduction in stand, it was very noticeable that the rows planted with Diplodia dry rot infected seed had a high percentage of weak, stunted plants, which either died or were so weakened that they reduced the yield. Similar conditions were noted in the rows planted with "Farmer's seed corn," but to a lesser degree.

The stand in the rows planted with healthy seed was not perfect due to several factors: (1) dry weather at planting time, (2) insects. The effect of these factors, however, was evenly distributed on all three lots.

Low yield—In the plots mentioned above, each sample of corn was planted in triplicate and at husking time the yields were weighed, the average taken of the three plantings and the yield computed in bushels

TABLE I. A COMPARISON OF THE STAND RESULTING FROM HEALTHY, DIPLODIA DRY ROT INFECTED AND "FARMERS" SEED CORN DURING 1922 AND 1923.

	Healthy seed		Seed infected with Diplodia dry rot		"Farmers" corn	
County	1922	1923	1922	1923	1922	1923
Dallas	88.6	73.9	87.8	67.0	87.8	66.9
Hardin	95.1	71.2	87.4	59.8	89.6	68.3
Henry	87.0	79.1	72.3	69.3	81.6	77.5
Marion No. 1	84.2	69.5	76.6	48.7	81.4	
Marion No. 2	89.4	74.1	83.1	57.6	85.1	68.2
Sioux	82.1		67.4		77.9	
Grundy		70.7		63.3		64.6
Webster		81.1		68.4		75.2
Average	87.7	74.2	79.1	62.1	83.9	70.1
Difference			8.6	12.1	3.8	4.1

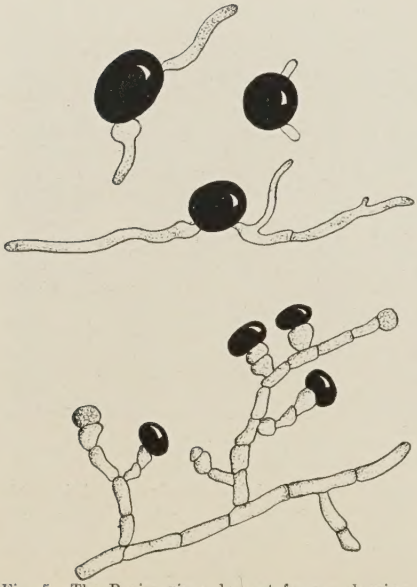

Fig. 5—The Basisporium dry rot fungus showing spores and mycelium. The spores are shiny, black, the mycelium is ashy gray as it appears on the tips of the kernels.

per acre. Table II lists these yields. For yield comparison see fig. 3.

The figures below represent the average of the yields from many different varieties and samples of corn. In many individual cases the rows planted with healthy seed produced at the rate of 10 and 15 bushels per acre more than the rows planted with seed prepared by the farmer. Seed germination would prevent this loss.

According to the table the yield from healthy corn in the 1922 trials was 7.7 bushels per acre more than that from the dry rot infected seed and 4.3 bushels per acre more than that from the "farmer's seed." In 1923 the healthy seed yielded 12.2 bushels per acre more than the dry rot infected and 5.8 bushels per acre more than the farmer's seed. The average increase for the two years would be 9.9 bushels in the case of the healthy and 5.1 bushels over the farmers' seed. This last figure really represents the loss to the farmer who did not discard the dry rot infected seed.

On the basis of an average of 50 acres of corn per farm in Iowa, it means that the average farmer lost over 200 bushels of corn in 1922. For the entire state, where approximately 10,000,000 acres were grown, this means a loss of 43,000,000 bushels. Germination tests will insure the farmer this increase per acre at a very nominal outlay of money. The testing can be done in a few days during the winter months when there frequently is little else can be done.

TABLE II. COMPARATIVE YIELD IN BUSHELS PER ACRE OF HEALTHY, DIPLODIA DRY ROT INFECTED AND FARMERS SEED.

	Healthy seed		Diplodia Dry rot infected seed		"Farmers" seed	
County	1922	1923	1922	1923	1922	1923
Dallas	81.8	59.1	76.6	55.3	75.6	55.2
Grundy		66.2		52.8		60.3
Hardin	62.1	58.9	55.4	49.1	56.9	55.2
Henry	66.4	55.4	58.3	48.9	64.8	53.0
Marion No. 1	65.0	66.4	58.4	44.5	58.8	
Marion No. 2	89.9	57.8	78.3	40.5	85.1	51.7
Sioux	59.4		51.6		55.0	
Webster		47.6		35.7		43.3
Average	70.8	58.9	63.1	46.7	66.5	53.1
Reduction per acre			7.7	12.2	4.3	5.8

BASISPORIUM DRY ROT

Basisporium dry rot, another important disease of corn, attacks the ears and shanks, causing the ears to lose 20 percent of their normal weight. It also injures the germ of the kernels, thereby reducing the stand and producing weak plants. The disease is caused by a fungus, *Basisporium gallarum,* which is present in corn fields to some extent every year. This last season, however, it was unusually prevalent. The average in experimental fields in seven counties in representative sections of the state was 9.1 percent of the ears infected. Many fields in wet areas of the state had a greater amount, some having as much as 50 to 60 percent of the ears attacked.

SIGNS OF BASISPORIUM DRY ROT

Infected ears can be recognized by the blackening of the cob around the kernel tips and also the chaff and the base of the kernels. This blackening is due to the great number of glossy black spores dispersed over the infected parts. Under an ordinary pocket magnifying glass these spores can readily be seen, appearing as small shiny, black balls. See spores and mold threads or hyphae in fig. 5.

The mold grows as a fine web of threads not easily visible with the unaided eye. Such an infected ear is shown at the left on the cover page. On the shank of the ear it destroys the connective tissue, leaving only the vascular fibers (fig. 6). The ears break off easily and the cob end has a brushy appearance (fig. 7). Infected kernels on the germinator are entirely dead or weak, often blackened by the fungus. The development of Basisporium dry rot is favored by heavy rainfall at the end of the growing season. Temperature is not as important as moisture for the growth of the mold. It grows at any temperature between 60° and 95° F.

The mold does not attack the roots nor work up inside of the stalk. It gains entrance under the husk and thence into the butt of the ear. The mold follows the moister parts of the ear, that is, the cob and kernel tips and in varying degrees attacks the latter. Basisporium mold grows better on nitrogenous than on starchy material. Hence the germ is more often attacked than the endosperm.

Fig. 6—Shank of corn rotted by *Basisporium gallarum.* Connective tissue destroyed leaving only vascular fibers.

While badly infected ears because of their light weight and loose kernels would never be selected for seed, slightly infected ears frequently get on the seed rack. These ears can only be detected and eliminated by germination tests.

CONTROL MEASURES

There is no known method or practice which will absolutely control all dry rots. Our experiments to date indicate, however, that it can be very materially reduced if careful attention is given to seed selection, seed germination and crop rotation.

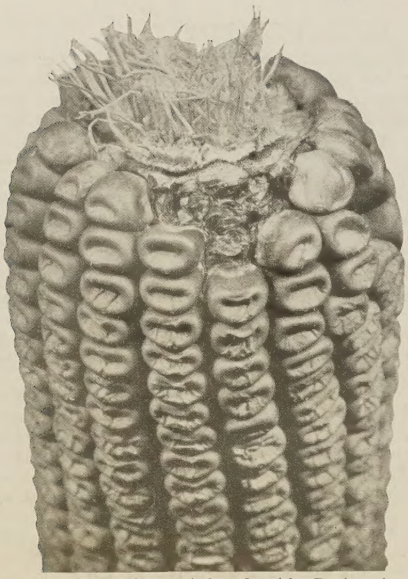

Fig. 7—Butt of ear infected with *Basisporium gallarum*. Note brushy ends of fibers and black spores of fungus on cob and chaff.

Seed selection—The damage caused by the dry rots is dependent on the moisture and temperature conditions when the corn is ripening. Many ears are badly molded, others are only partially affected. Even after the corn is gathered the mold may continue its work. is important, therefore, that Therefore, each farmer must practice very rigid selection of his seed corn, selecting it in the field as soon as the ears are well filled and dented. The usual practice has been to select before frost, but often the mold has made considerable progress by that time. Consequently earlier selections, if the corn is sufficiently mature, is to be encouraged. In addition to giving attention to type, select seed ears from green standing stalks with unbroken, healthy shanks. After selection, store the seed in a cool, dry place, to prevent the mold from spreading.

Seed germination—Even with the most careful field selection many ears which appear healthy show signs of mold when tested. Badly shrunken or discolored kernel tips may indicate dry rot, but these symptoms cannot be entirely relied upon. The presence of infections can only be discovered by germinating tests. After trying several different kinds of seed corn germinators, the modified rag doll type was found the most suitable for ordinary farm practice. This consists of a strip of heavy glazed manilla paper, 6 feet long by 12 to 14 inches wide, on which a strip of wet muslin of the same dimensions is placed. Six or eight kernels from each ear should be placed in a row cross wise of the cloth and the ears should be laid away in consecutive order or numbered. One doll will test from 25 to 30 ears.

After the kernels are placed on the cloth, the doll should be rolled up, soaked for an hour in warm water, then wrapped in burlap and kept at a temperature of 75° to 80° F. for five or six days. Sprinkle the dolls each day with warm water to prevent drying out. At the end of the germination period, the test may be read and those ears which show infection discarded. The cloths may be boiled and used again.

Crop rotation—If corn is grown consecutively for a number of years on a piece of ground, these diseases become concentrated there and under favorable weather conditions cause heavy losses. A long system of rotation should greatly reduce this danger. This practice is also best from the standpoint of insect injury and depletion of fertility. Either a four or five year rotation, so arranged that corn is not grown more than two years in succession is to be encouraged.